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MIL-PRF-19500 Appendix J Task Group Status Update

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MIL-PRF-19500 Appendix J Task Group

- The Appendix J Task group was started to address the need for military grade PEDs in Department of Defense programs. Some department of defense programs use plastic encapsulated versions of military discrete semiconductors and have to screen each lot of procured devices prior to usage in their programs. The goal of this effort is to enable the user community to have access to a military qualified plastic encapsulated discrete semiconductor available and eventually have a space qualified plastic encapsulated device.
- There are several concerns with commercial off the shelf PEDs
  - No control over device changes – the military and space user community have no control or oversight into device design changes made by the device manufacturer.
  - Parts Obsolescence – Life cycle for commercial off the shelf PEDs is technology dependent and varies from manufacturer to manufacturer and by part number; whereas many military grade devices have been manufactured for decades and continue to be manufactured

MIL-PRF-19500 Appendix J Task Group

- Lower operating temperature range – commercial off the shelf devices typically have a lower operating temperature range than comparable military grade. For example a hermetic military grade 2N2222 transistor operating temperature range is -65C to +200C, while the commercial nonhermetic version operating temperature range is -55C to +150C or less.
- Costly screening and qualification testing required for each lot of commercial off the shelf PEDs utilized because there is no guarantee that the device design won't change between procurements of the same part number.
- Traceability, traceability - Traceability is required for military and space qualified products. Traceability may not be available for COTS devices

JC13 Appendix J Task Group Metrics

- Conducted two (2) Webex/ Teleconference since January 2022 JEDEC meeting.
  - Average meeting attendance was ten (10).

MIL-PRF-19500 Appendix J Part Advantages

- DLA Land and Maritime overview and audits of qualified manufacturers.
- DLA certified manufacturer and DLA qualified manufacturing lines.
- Standard military qualified nonhermetic discrete component.
- Standard screening and qualification conformance inspection flows.
- Screening and qualification conformance flows based on hermetic flow and proven Army testing.
- No up-screening required or schedule delays due to up-screening saving schedule and money for most military applications.
  - COTS appear cheaper at purchase because the cost of up-screening the lot is not included in the program parts cost for many programs.

MIL-PRF-19500 Appendix J Status

- MIL-PRF-19500 Revision R with Appendix J released on July 24, 2021.
- Developed and sent document with background on glass transition temperature measure concerns and list of questions to poll the industry experts.
  - Waiting on response from the industry experts
- There are several non hermetic slash sheets in development. Three Slash sheets waiting glass transition temperature measurement method to be resolved.
  - Interim solution is to address in the slash sheet until MIL-PRF-19500
  - * 4.5.4 Glass transition temperature. The glass transition temperature test shall be conducted in accordance with MIL-PRF-19500. The use of an alternate test method is permitted provided that the same alternate test method is used to satisfy both groups B and E requirements. Subsequent changes to a different test method shall require a correlation test.

MIL-PRF-19500 Appendix J Status

- Glass transition temperature measurement method

- Developed and sent document with background on glass transition temperature measurement method concerns and list of questions to poll the industry experts.

  - Waiting on response from manufacturers that supported discussion at January 2022 JEDEC meeting.

MIL-PRF-19500 Appendix J Status

- Proposed wording for a process monitor.
  - Glass transition temperature measurement: The manufacturer shall establish an effective monitoring program for glass transition temperature measurement. A periodic in-line monitor shall be implemented to verify that the device epoxy material and encapsulation process to ensure device Tg.
- Reviewed the questions at the last Appendix J tag-up meeting and sent to DLA.
  - Questions were sent to industry experts for input.
  - DLA to poll the MIL-PRF-19500 manufacturers and users.

MIL-PRF-19500 Appendix J Status

1. Should different glass transition measurements test methods be allowed for characterization or recharacterization, if the same method is used consistently?

2. Should differential scanning calorimetry glass transition measurement test method be utilized for epoxy lot-to-lot variation testing? If not, which is the preferred glass transition temperature measurement method?

3. Would an inline process monitor be preferrable to having a Group B (every lot) or Group C (annual test) test frequency?

4. What pitfalls could be expected when epoxy device encapsulating processes are not in control?

5. Is performing glass transition temperature measurement on completed device a standard practice? If so, what should the process look like?

6. Can the glass transition test measurement process monitor during the encapsulation process correlate to the epoxy shelf life?

7. Should there be general storage conditions listed in the department of defense specifications for the epoxy raw material and for the finished product?

MIL-PRF-19500 Appendix J Status

- Epoxy encapsulant over glass construction:
  - Is TM5011 still required?
  - Is sequential testing required?
  - Are changes to the test flow needed?

Planned slash sheets for Appendix J qualification

19500 Slash sheet	Device Type	Part number	Additional information
672	NPN Silicon Switching Transistor	2N2222	Cross references to hermetic /255
674	NPN Silicon Low-Power Transistor	2N2484	Cross references to hermetic /376
686	PNP Silicon Switching transistor	2N2907	Cross references to hermetic /291
691	Silicon switching diode	TBD	Cross references to hermetic /116
694	NPN Silicon Low-Power Transistor	2N3700	Cross references to hermetic /391

Planned slash sheets for Appendix J qualification

19500 Slash sheet	Device Type	Part number	Additional information
695	PNP Silicon Switching transistor	2N4033	Cross references to hermetic /512
696	N-Channel Power MOSFET	TBD	TBD
714	N-Channel Power MOSFET	2N7558 – 2N7560	TBD
715	N-Channel Power MOSFET	2N7563 – 2N7565	TBD
716	Unipolar Transient Voltage Suppressor diode	1N5555 and others	Cross references to hermetic /500
717	Bipolar Transient Voltage Suppressor diode	1N6036 – 1N6072	Cross references to hermetic /507

Status of Draft Slash Sheets for Appendix J Qualification

- Three slash sheets have been released for draft and the comment due date has expired.
  - Remaining issue is the glass transition temperature measurement method.
  - Interim resolution is to address in slash sheet until results received from industry experts.

19500 Slash sheet	Device Type	Part number	Additional information
672	NPN Silicon Switching Transistor	2N2222	Cross references to hermetic / 255
716	Unipolar Transient Voltage Suppressor diode	1N5555 and others	Cross references to hermetic / 500
717	Bipolar Transient Voltage Suppressor diode	1N6036 – 1N6072	Cross references to hermetic / 507

External Visual Test Method Review

- Task group started comparison review of JEDEC external visual inspection method JESD22-B101C versus MIL-STD-750 test method 2071.

- Is MIL-STD-750 test method 2071 for external visual inspection sufficient for nonhermetic devices?

External Visual Test Method Comparison

Visual Criteria	JESD22-B101C	MIL-STD-750-2 TM2071
Dry gas blow off or vacuum particle removal	Allowed	No provision
Magnification	With unaided eye or 3X – 7X	20X minimum
Uncertain observation magnification	Up to 30X	40X maximum, higher magnification may be used to further examine anomaly
Contamination	Yes	Yes
Nonconforming dimensions	Yes	Yes(?)

External Visual Test Method Review (Cont.'d)

Visual Criteria	JESD22-B101C	MIL-STD-750-2 TM2071
Marking	Illegible characters, deformed broken, faint, missing, extraneous marks, doubled, wrong	Yes (laser marking only)
Leads	Yes	Yes
Lead finish	Yes	Yes
Package finish	No	Yes
Molding and mold compound	Yes	No
Solder balls	Yes (?)	No

External Visual Test Method Review (Cont.'d)

Visual Criteria	JESD22-B101C	MIL-STD-750-2 TM2071
Substrate	Yes	No
Exposed backside Silicon	Yes	No
Ceramic packages	No	Yes
Transparent glass packages	No	Yes
Hermetic packages	?	Yes
Critical sealants	Yes	No
Attachments	Yes	No (?)
Foreign Material	Yes	Yes

MIL-PRF-19500 Appendix J Future Plans

- Continue having regular webex meetings to address test method issues related to Appendix J devices.
  - Glass Transition Temperature measurement method
  - Continue review of External Visual Inspection test methods: MIL-STD-750-2, test method 2071 and JESD22-B101C.
  - Review is being planned for additional JEDEC and military test methods such as: Acoustic Microscopy, HAST, Autoclave etc.
  - Results of task group test method reviews will be presented to DLA
- Address epoxy encapsulant over glass construction in regards to TM5011, sequential testing, and/or modifications to the test flow

Thank you!

- We would like to express our appreciation to the task group members, NASA NEPAG and SLS programs, Government Working Group, and Microchip Technologies for their continued support of this effort.

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Acronyms

- AC – Autoclave
- CDM – Charged Device Model
- DLA – Defense Logistics Agency
- DPA – Destructive Physical Analysis
- EEE – Electrical, Electronic, and Electromechanical
- EP – Engineering Practice
- ESD – Electrostatic Discharge
- HAST – Highly Accelerated Stress Testing
- HTRB – High Temperature Reverse Bias
- IOL – Intermittent Operating Life
- JAN – Joint Army Navy

Acronyms

- JANPTX - Joint Army Navy Plastic eXtra Testing
- JANPTXV - Joint Army Navy Plastic eXtra Testing with Visual
- JANPS – Joint Army Navy Plastic Space
- JANS – Joint Army Navy Space
- JANTX – Joint Army Navy eXtra Testing
- JANTXV – Joint Army Navy eXtra Testing with Visual
- JEDEC – Joint Electronic Devices Council
- NASA – National Aeronautics and Space Administration
- NEPAG – NASA EEE Parts Assurance Group

Acronyms

- PDA – Percent Defective Allowable
- PEDS – Plastic Encapsulated Discrete Semiconductors
- RH – Relative Humidity
- SAE – Society of Automotive Engineers
- SLS – Space Launch System
- t – time (i.e. t = 96 hours)
- TBD – To Be Determined
- Tg – Glassivation Temperature
- Tj – Junction Temperature
- THB – Temperature Humidity Bias
- TS – Terminal Strength
- UHAST – Unbiased Highly Accelerated Stress Test

Backup Data

MIL-PRF-19500 Expanded to include Non-hermetic

MIL-PRF-19500

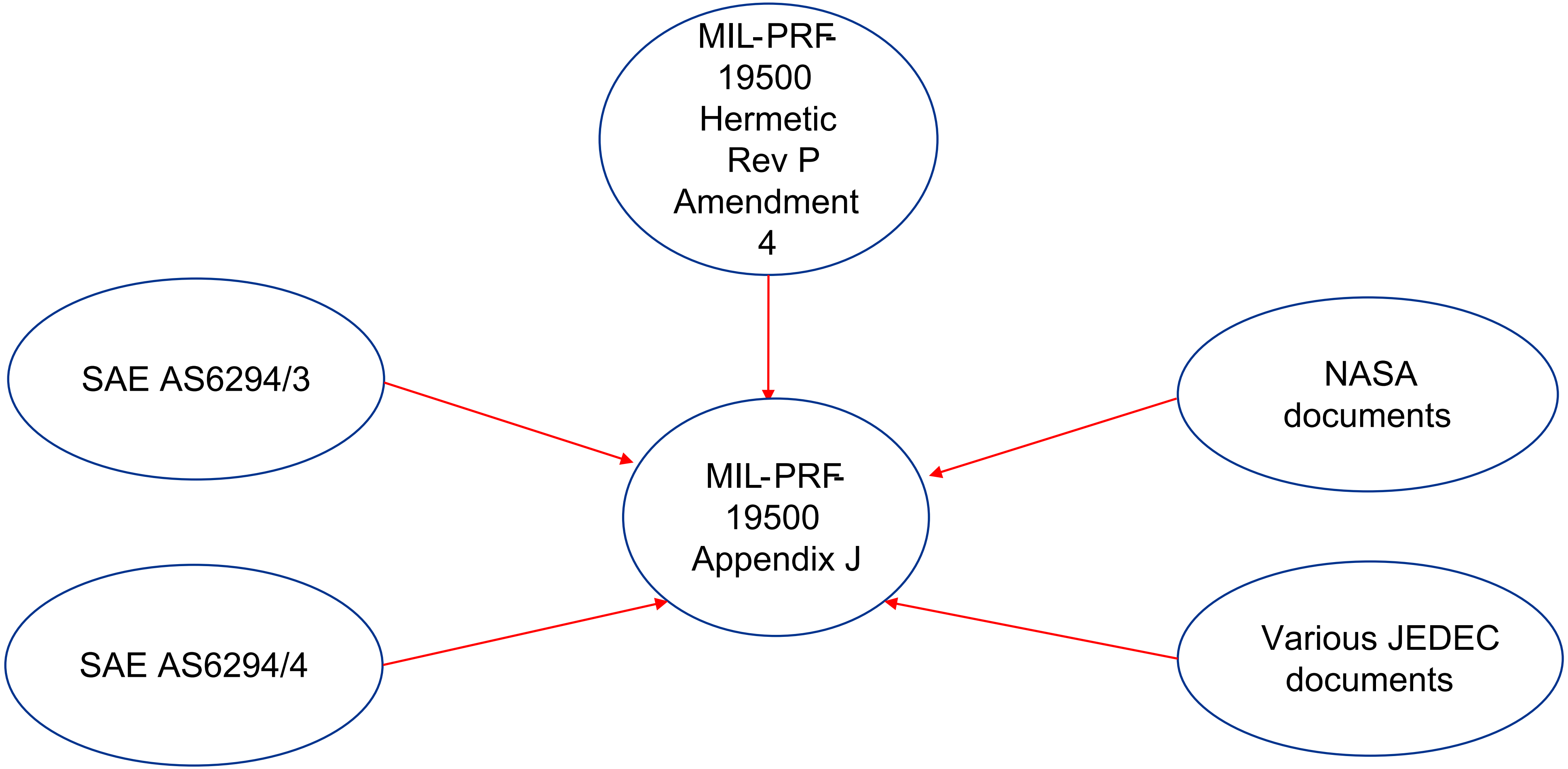
Appendix J Non-hermetic devices

Hermetic devices

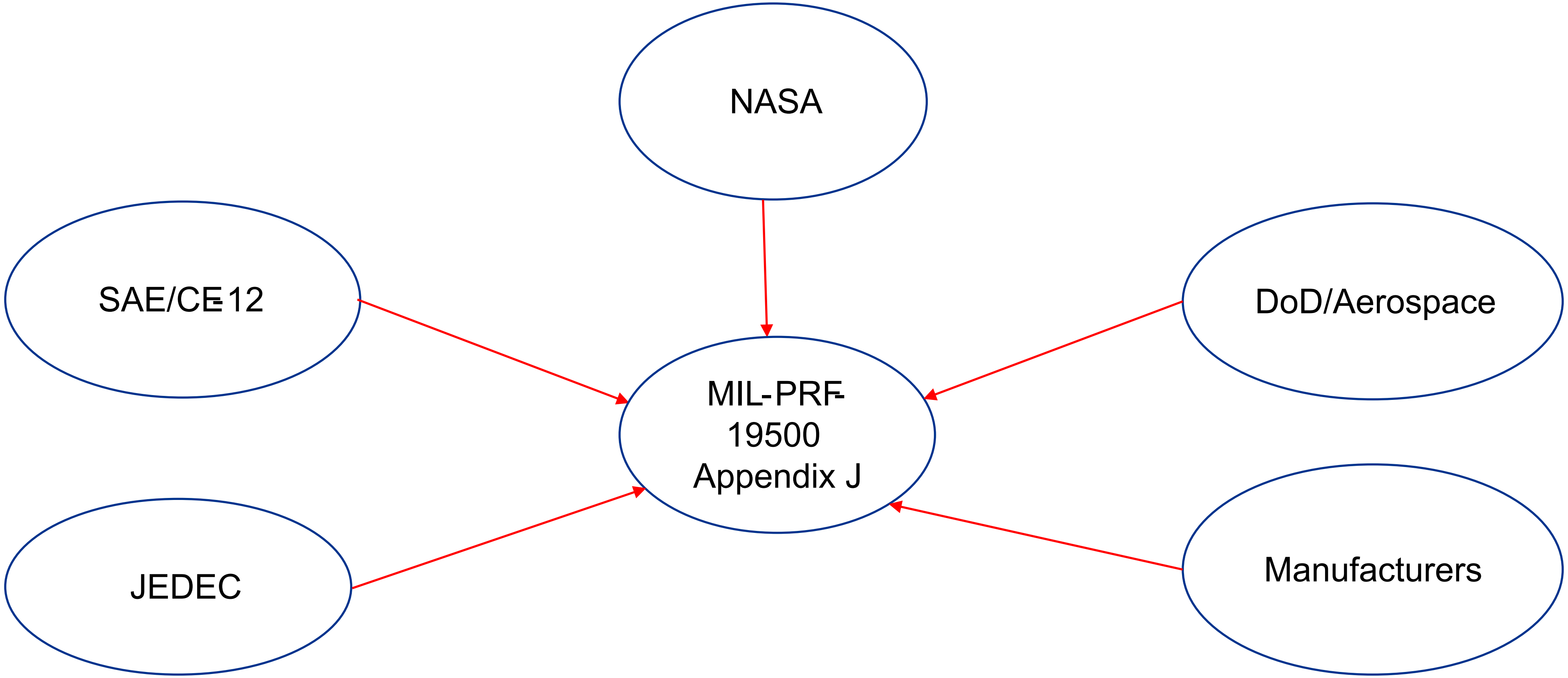
JANP, JANPTX, JANPTXV, JANPS(?)

JAN, JANTX, JANTXV, JANS

MIL-PRF-19500 Appendix J Sources



MIL-PRF-19500 Appendix J Stakeholders



Appendix J JEDEC JC13.1 Survey Ballot on Glass Transition Temperature Test Methods Utilized

TASK GROUP SURVEY FROM: MIL-PRF-19500 Appendix J

Number: 001

Dated: 11/16/21

Survey Period: 11/22/21 – 12/22/21

Background: This survey is being submitted to JC14 and JC13.1 committee members to collect inputs for the 19500 Appendix J Task Group. Results of this survey will be reviewed in the January 2022 JEDEC meeting.

One of the discrete semiconductor manufacturers that is in the process of qualifying their first nonhermetic encapsulated military qualified discrete semiconductor has found that there are no test laboratories using the ASTM E1640 Glass Transition (Tg) Temperature Measurement Test method. The manufacturer brought their concerns to the 19500 Appendix J task group for assistance in determining the glass transition temperature test method utilized by most nonhermetic encapsulated semiconductor manufacturers.

Appendix J JEDEC JC13.1 Survey Ballot on Glass Transition Temperature Test Methods

Questions	Responses	Comments
1. Which glass transition temperature test method does your facility or test laboratory utilize/use to characterize and monitor glass transition, Tg?		
2. How is the glass transition temperature testing performed? a. On finished product samples? b. Or on raw material samples?		
3. What is the frequency of glass transition testing?		
4. How is epoxy mold compound accepted (e.g., certificate of conformance, receiving inspection test, rely on product testing)?		

Appendix J JEDEC JC13.1 Survey Ballot on Glass Transition Temperature Test Methods

Please provide responses as follows:

For question (1) Please provide specific input on the glass transition test temperature method utilized

For question (2) Please provide specific inputs

For question (3) Please provide specific inputs

For question (4) Please provide specific inputs

JEDEC JC13.1 Ballot on Glass Transition Temperature Test Methods Response Summary (Cont.'d)

- There were a total of 8 responses.
  - Six no comment responses.
  - Two comment responses.
-

JEDEC JC13.1 Ballot on Glass Transition Temperature Test Methods Response Summary (Cont.'d)

Questions	Responses	Comments
1. Which glass transition temperature test method does your facility or test laboratory utilize/use to characterize and monitor glass transition, Tg?	Both TMA and DMA. In the TMA this is determined by the inflection point between the region below and above Tg. In the DMA it is based on the onset of the transition from the storage modulus curve.	In line with ASTM E1640
1. How is the glass transition temperature testing performed? a. On finished product samples? b. Or on raw material samples?	On raw material samples of specified geometry	
1. What is the frequency of glass transition testing?	During development and on incidental basis. The supplier monitors this data on supplier batches as per the agreed frequency	
1. How is epoxy mold compound accepted (e.g., certificate of conformance, receiving inspection test, rely on product testing)?	Certificate of conformance	

JEDEC JC13.1 Ballot on Glass Transition Temperature Test Methods Response Summary (Cont.'d)

- Second comment response is as follows:

- Comments: (5-2) Comment(s) on survey: We currently do not make any product that would be covered under this survey. However, we would be okay with moving forward with ASTM E1640 as the base standard to move forward.

Appendix J JEDEC JC13.1 Ballot on Glass Transition Temperature Test Methods

- A manufacturer working on qualifying plastic parts ran into a problem with the glass transition temperature Group E qualification
  - Couldn't find a local test laboratory that performs the glass transition temperature test per test method ASTM E1640.
- Manufacturer asked the task group and DLA for assistance on this subject.

Appendix J JEDEC JC13.1 Ballot on Glass Transition Temperature Test Methods

- Task group discussed the Glass transition temperature issue and following observations was made.

- Three (3) general techniques utilized for Glass Transition Temperature Measurement (Tg):

1. Differential Scanning Calorimetry (DSC)

2. Thermal Mechanical Analysis (TMA)

3. Dynamic Mechanical Analysis (DMA)

Appendix J JEDEC JC13.1 Ballot on Glass Transition Temperature Test Methods

- **Differential scanning calorimetry** (**DSC**) is a thermoanalytical technique in which the difference in the amount of heat required to increase the temperature of a sample and reference is measured as a function of temperature. Both the sample and reference are maintained at nearly the same temperature throughout the experiment. Generally, the temperature program for a **DSC** analysis is designed such that the sample holder temperature increases linearly as a function of time. The reference sample should have a well-defined heat capacity over the range of temperatures to be scanned. (Source: https://en.wikipedia.org)

Appendix J JEDEC JC13.1 Ballot on Glass Transition Temperature Test Methods

- **Thermal Mechanical Analysis** (**TMA**) is a method used to determine the thermal properties of polymeric materials. Using minimal force at a range of temperatures, **TMA** can be used to find a variety of thermal and mechanical properties, including thermal expansion. (source: https://www.element.com/materials-testing-services/thermomechanical-analysis)
- **Dynamic Mechanical Analysis** (**DMA**) s a technique used to study and characterize materials. It is most useful for studying the viscoelastic behavior of polymers. A sinusoidal stress is applied and the strain in the material is measured, allowing one to determine the complex modulus. The temperature of the sample or the frequency of the stress are often varied, leading to variations in the complex modulus; this approach can be used to locate the glass transition temperature[1] of the material, as well as to identify transitions corresponding to other molecular motions. (source: https://en.wikipedia.org)

Glass Transition Temperature Test Methods

This is not an all-inclusive list of glass transition test methods

- ASTM D7028-07(2015) Standard Test Method for Glass Transition Temperature (Tg) of Polymer Matrix Composites by Dynamic Mechanical Analysis (DMA)
- ASTM E1356, Standard Test Method for Assignment of the Glass Transition Temperature by Differential Scanning Calorimetry.
- ASTM E1545, Standard Test Method for Assignment of the Glass Transition Temperature by Thermomechanical Analysis
- ASTM E1640, Standard Test Method for Assignment of the Glass Transition Temperature by Dynamic Mechanical Analysis
- ASTM E1824-19, Standard Test Method for Assignment of a Glass Transition Temperature using Thermomechanical Analysis: Tension Method

MIL-PRF-19500 Appendix J Comparison to SAE AS6294/3,/4

- SAE AS6294/3 and AS6294/4 PEDS documents were developed to provide the user community with standard screening and qualification guidelines for commercial off the shelf discrete semiconductors utilized in space and military applications.

- MIL-PRF-19500 Appendix J document development focus has been to provide government and military users with the following: DLA Land and Maritime audited and certified manufacturers, DLA qualified military product, standard screening flows, non-hermetic part number prefix scheme, and standard products.
  - DLA Land and Maritime initial manufacturer audits required to certify and qualify manufacturing lines to supply military qualified non-hermetic MIL-PRF-19500 product.
  - Periodic DLA manufacturer re-certification audits identical to the hermetic audits with exceptions due to packaging are required.
  - Initial DLA Land and Maritime device qualification will be for JANTXV-like and JANTX-like levels only. Initial part numbering scheme prefix is planned to be JANP, JANPTX, and JANPTXV.

MIL-PRF-19500 Appendix J Screening Differences

- 19500 Appendix J provides standard military screening and qualification flows based on:
  - MIL-PRF-19500 hermetic screening and qualification flows with exceptions due to packaging.
  - Some example portions of SAE 6294/3 and 6294/4 that were incorporated into Appendix J such as:
    - Construction analysis
    - Sequential test flow
    - Moisture Sensitivity level
  - Major change table added to Appendix J to address different requalification requirements for plastic military qualified devices.

MIL-PRF-19500 Appendix J Screening Differences

- Non-hermetic screening flow follows the hermetic screening with differences listed below and as shown in the following slides:

  - Temperature cycling is performed at a lower temperature range than hermetic devices.

  - High Temperature Reverse Bias performed at 125°C ambient temperature or 80 percent of maximum operating temperature if maximum operating temperature is less than 150°C.

  - Burn-in performed at 125°C junction temperature or 80 percent of maximum operating temperature if maximum operating temperature is less than 150°C.

  - Radiography ‘as specified’.

  - Acoustic Microscopy screening ‘as specified’.

  - Non hermetic JANPXV and JANPX no hermeticity testing required

MIL-PRF-19500 Appendix J Screening Comparison to Hermetic Devices

	Hermetic Flow		Nonhermetic flow	
Screen	JANTXV	JANTX	JANTXV-Like	JANTX-Like
Die visual for glass diodes	N/A	N/A	N/A	N/A
Internal Visual	100 percent	N/A	100 percent	N/A
High Temperature Non Operating Life	Optional	Optional	Optional	Optional
Temperature Cycling	Condition C*	Condition C*	Condition G**	Condition G**

* Method 1051 condition C temperature range is -55°C to +175°C.

** Method 1051 condition G temperature range is -55°C to +150°C or maximum storage temperature.

MIL-PRF-19500 Appendix J Screening Comparison to Hermetic Devices (Cont.'d)

	Hermetic Flow		Nonhermetic flow	
Screen	JANTXV	JANTX	JANTXV-Like	JANTX-Like
Surge	100 Percent	100 Percent	100 Percent	100 Percent
Thermal Impedance	100 Percent	100 Percent	100 Percent	100 Percent
Constant Acceleration	Optional	Optional	N/A	N/A
PIND	N/A	N/A	N/A	N/A
Instability Shock Test Axial leaded diodes only	N/A	N/A	N/A	N/A
Hermetic Seal	Optional	Optional	N/A	N/A

MIL-PRF-19500 Appendix J Screening Comparison to Hermetic Devices (Cont.'d)

	Hermetic Flow		Nonhermetic flow	
Screen	JANTXV	JANTX	JANTXV-Like	JANTX-Like
Serialization	N/A	N/A	N/A	N/A
Interim electrical parameters	100 Percent	100 Percent	100 Percent	100 Percent
High Temperature Reverse Bias	100 Percent	100 Percent	100 Percent**	100 Percent**
Interim electrical parameters for PDA	100 Percent	100 Percent	100 Percent	100 Percent
Burn-in	100 Percent*	100 Percent*	100 Percent**	100 Percent**

MIL-PRF-19500 Appendix J Screening Comparison to Hermetic Devices (Cont.'d)

	Hermetic Flow		Nonhermetic flow	
Screen	JANTXV	JANTX	JANTXV-Like	JANTX-Like
Final electrical parameters for PDA	100 Percent	100 Percent	100 Percent	100 Percent
Hermetic Seal	100 Percent	100 Percent	N/A	N/A
Radiography	As specified	As specified	As specified	As specified
Acoustic Microscopy	N/A	N/A	As specified	As specified
External Visual	N/A	N/A	100 Percent	100 Percent
Case Isolation	100 Percent	100 Percent	N/A	N/A

MIL-PRF-19500 Appendix J Group A Qualification Differences

- Non-hermetic qualification flow = hermetic (except as noted)
  - Temperature cycling is performed at a lower temperature range than hermetic devices.
  - Added Autoclave or unbiased HAST (sequential test flow) option testing for small die flow which is Group B testing for the small die flow devices.
  - Acoustic Microscopy screening will be 'As specified' on a slash sheet by slash sheet basis for non hermetic JANTXV-like and JANTX-like devices.

MIL-PRF-19500 Appendix J Group A Qualification Differences

- Group A subgroup 1, small die flow (Sequential Testing)
  - Highly Accelerated Stress Testing
  - 130°C/ 85% RH t = 96 hours, or
  - 110C°/ 85% RH t = 264 hours, or
  - Autoclave – 121°C/ 100% RH t = 96 hours
  - Temperature cycling test condition G instead of condition C

MIL-PRF-19500 Appendix J Group B Qualification Differences

- Non-hermetic qualification flow = hermetic (except as noted)
  - Temperature cycling performed at a lower temperature range than hermetic devices.
  - Life testing (340 hours) performed at lower temperature (+125°C) or 80 percent of maximum operating temperature.
  - Acoustic Microscopy screening is required as part of the decapsulation design verification process.
  - Added Autoclave or unbiased HAST sequential testing for non small die flow products (sequential test flow).
  - Added glass transition (Tg) temperature test.

MIL-PRF-19500 Appendix J Group B Qualification Differences

- Non-hermetic qualification flow = hermetic (except as noted)
  - Group B subgroup 2
    - Preconditioning per J-STD-020
    - Temperature cycling 100 cycles
  - Group B subgroup 4
    - Acoustic Microscopy
    - Design verification using MIL-STD-750 test method 2075 and MIL-STD-1580 requirement 16 for plastic criteria.
  - Group B subgroup 7
    - Glass transition temperature (Tg)

MIL-PRF-19500 Appendix J Group C Qualification Differences

- Non-hermetic qualification flow = hermetic (except as noted)
  - Group C subgroup 2
    - Preconditioning per J-STD-020
    - Temperature cycling 500 cycles

  - Group C subgroup 3
    - Moisture sensitivity level
    - Highly Accelerated Stress Testing or
    - Temperature cycling test condition G instead of condition or
    - 1000 hour temperature humidity test – 85°C/ 85% RH

MIL-PRF-19500 Appendix J Group D Qualification Differences

- Non-hermetic qualification flow = hermetic (except as noted)
  - Group D subgroup 2 – steady state total dose radiation testing.
    - Device burn-in completion will be required prior to beginning total dose radiation testing. Sample size of 10 – 15 devices required for radiation testing is specified in the draft document.

MIL-PRF-19500 Appendix J Group E Qualification Differences

- Non-hermetic qualification flow = hermetic (except as noted)
  - Group E subgroup 1
    - Preconditioning per J-STD-020
    - HAST or Temperature Humidity Bias (THB)
    - Temperature cycling 200 cycles versus 500 for hermetic devices
    - Group E subgroup 1a
    - Preconditioning per J-STD-020
    - Temperature cycling 500 cycles
    - Group E subgroup 9
    - Acoustic Microscopy
    - Moisture sensitivity level
    - Acoustic microscopy

MIL-PRF-19500 Appendix J Group E Qualification Differences

- Non-hermetic qualification flow = hermetic (except as noted)
  - Group E subgroup 10
    - Glassivation temperature - Tg
    - Plastic evaluation per MIL-STD-883 method 5011
    - Construction analysis per SAE AS6294/3
    - Outgassing and flammability per NASA-STD-6001

MIL-PRF-19500 Appendix J Comments

- Non-hermetic qualification flow = hermetic (except as noted)
  - Group E subgroup 11
  - Single Event Effect Testing – Characterization curves will be required for MOSFETs. Characterization data will be required for Schottky diodes with a forward current rating greater than or equal to one (1) Amp.
  - A note was added to Group E qualification table to clarify radiation qualification process. "Radiation testing not required unless specified in the slash sheet."

MIL-PRF-19500 R Second draft Appendix J Comments

- Conditions for UHAST in B2 are listed as “130C/ 100% RH, 96 hours”.

UHAST, or	JESD22 -A118	130C/ 100% RH, 96 hours, or
UHAST		110C/85%RH, 264 hours

- Should this be “130°C/ 85% RH, 96 hours” instead? Consensus is that the UHAST humidity conditions should be changed to 85% at 130°C.

MIL-PRF-19500 R Second Draft Appendix J Comments

- Questions involved TM5011 and a type of construction that involves using a glass diode inside a plastic encapsulant.

- Does the TM5011 still apply to this encapsulant over glass diode construction? Believe that it still would but don't know whether that type construction might require a different set of conditions.

- Would an encapsulant over glass construction still require all of the sequential testing?

- Would an encapsulant over glass construction require other modifications to the test flow?

MIL-PRF-19500 Appendix J Comment/Concerns

- In order to supply non-hermetic JANP devices to this appendix a manufacturer needs to first be DLA certified and qualified for hermetic devices in accordance with appendix C or D and perform all of the required screening and quality conformance testing specified herein and in accordance with 3.2.1.1.
- Intent
  - DLA certified manufacturer
  - Manufacturer audited and certified by DLA on a periodic basis
  - Standard screening and qualification flow for plastic military grade devices.
  - DLA has control of design and manufacturing processes
- Options:
  - Revise Scope?
  - Leave unchanged? Consensus decision is to leave unchanged.

NASA and Government Documents

- MSFC-STD-3012 – MSFC Technical Standard, Electrical, Electronic, and Electromechanical (EEE) Parts Management and Control Requirements for MSFC Space Flight Hardware
- PEMS-INST-001 – Instructions for Plastic Encapsulated Microcircuit (PEM) Selection, Screening, and Qualification
- DEPARTMENT OF DEFENSE STANDARDS
  - MIL-STD-883, Method 5011 Evaluation and Acceptance of Procedures for Polymeric Materials

JEDEC and Industry Documents

- JESD22-A101 - Steady-State Temperature-Humidity Bias Life Test
- JESD22-A102 - Accelerated Moisture Resistance - Unbiased Autoclave
- JESD22-A110 - Highly Accelerated Temperature and Humidity Stress Test (HAST)
- JESD22-A113 - Preconditioning of Non-hermetic Surface Mount Devices Prior to Reliability Testing
- JESD22-A118 - Accelerated Moisture Resistance - Unbiased HAST
- JESD22-B101 - External Visual
- J-STD-020 - Moisture/Reflow Sensitivity Classification for Non-hermetic Solid State Surface Mount Devices
- J-STD-033 - Handling, Packing, Shipping and use of Moisture/Reflow Sensitive Surface Mount Devices

JEDEC and Industry Documents

- J-STD-035 - Acoustic Microscopy for Non-hermetic Encapsulated Electronic Components
- SAE International
  - AS6294/3 - Requirements for Plastic Encapsulated Discrete Semiconductors in Space Applications
- ASTM INTERNATIONAL (ASTM)
  - ASTM E1640 - Standard Test Method for Assignment of the Glass Transition Temperature By Dynamic Mechanical Analysis
  - ASTM E595 - Standard Test Method for Total Mass Loss and Collected Volatile Condensable Materials from Outgassing in a Vacuum Environment

MIL-PRF-19500 Appendix J Comment/Concerns

TABLE J-I Testing guidelines for changes to a qualified product. 1/ 2/ 3/ 4/ 5/ 6/ 7/ 8

Changes (see D.3.4.2)	JANP/PTX/PTXV Product Subgroups required to be performed and data submitted to DLA Land and Maritime	JANPS Product Subgroups required to be performed and data submitted to DLA Land and Maritime	Samples to be submitted to qualifying activity in accordance with tables and subgroups herein
1. Die properties			
a. Construction technique (alloy, planar, mesa)	Group A, C6, D	Groups A, B, C, D, E	C6, 2 samples
b. Substrate, epitaxial properties	Group A, C6, D1	Group A, C6, D1	C6, 2 samples
c. Diffusion method (alloy, ion implant, diffusion)	Group A, C6, D1, D2	Group A, B5, D1, D2	C6, 2 samples
d. Surface deposition – passivation	Group A, ~~test method 1039 of MIL-STD-750, cond A~~, Screen 10, C6, D2	Group A, B5, D2	C6, 2 samples
e. Surface deposition – front metal (material / process)	Group A, B2, and C6	Group A, B3, and C6	C6, 2 samples
f. Surface deposition – back metal (material / process)	Group A, B2, C6, and E4	Group A, B3,C5, C6, and E4	C6, 2 samples

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TABLE J-I Testing guidelines for changes to a qualified product. 1/ 2/ 3/ 4/ 5/ 6/ 7/ 8

Changes (see D.3.4.2)	JANP/PTX/PTXV Product Subgroups required to be performed and data submitted to DLA Land and Maritime	JANPS Product Subgroups required to be performed and data submitted to DLA Land and Maritime	Samples to be submitted to qualifying activity in accordance with tables and subgroups herein
1. Die properties			
g. Surface deposition – glassivation over metal (material / process)	Group A, ~~test method 1039 of MIL-STD-750, cond A~~, screen 10, C6	Group A, B5, D2	C6, 2 samples
h. Surface deposition – Die protective coating (material / process)	Group A, test method 1039 of MIL-STD-750, cond A, screen 10, C6	Group A, B3, C6	C6, 2 samples
i. Geometry - die size	Group A, C6, D, E4	Group A,B,C,D,E	C6, 2 samples
j. Geometry - die thickness	Group A, C6, E4, B4	Group A, C6, E4, B3	C6, 2 samples
k. Fab location move	Groups A, B, C, D, E, Notify qualifying activity	Groups A, B, C, D, E, Notify qualifying activity	One each B and C
L Wafer diameter	Groups A, B, C, D, E, Notify qualifying activity	Groups A, B, C, D, E, Notify qualifying activity	

MIL-PRF-19500 Appendix J Comment/Concerns

TABLE J-I Testing guidelines for changes to a qualified product. 1/ 2/ 3/ 4/ 5/ 6/ 7/ 8

Changes (see D.3.4.2)	JANP/PTX/PTXV Product Subgroups required to be performed and data submitted to DLA Land and Maritime	JANPS Product Subgroups required to be performed and data submitted to DLA Land and Maritime	Samples to be submitted to qualifying activity in accordance with tables and subgroups herein
2. Package properties			
a. Package material / dimension change (base, plug, lead, lead frame, mold compound)	Groups B1, B2, B3, C1~~C7~~, D2, E4	Group B1, B2, B3, Group C1-C6,~~C7~~, D2 and E4	
b. Die attach method / material	Groups C3, C6, E1, E4	Groups B3, C3, C6, E4	C6, 2 samples
c. Bond wire material / diameter / process	Groups B2, B3, C3, B4	Groups B3, C3, C6	B3, 2 samples
d. encapsulation process	Groups B2, B3, C3, C7, D2	Groups B3, C3, C7, D2	B3, 2 samples
e. Assembly location move	Notify qualifying activity	Notify qualifying activity	As required
f. marking qualification	Groups C2, and, test methods 1021	Groups C2, and, test methods 1021	2 samples

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TABLE J-I Testing guidelines for changes to a qualified product. 1/ 2/ 3/ 4/ 5/ 6/ 7/ 8

1/ Acceptable supporting data may be submitted to reduce or eliminate required testing.

2/ When variable data is required for applicable groups A and C testing, data histograms providing acceptable parameter data summaries may be submitted in place of variables.

3/ If changes involve more than one device type from the same certified line, contact the qualifying activity to determine appropriate selection of device type(s) to be selected for testing.

4/ The qualifying activity may add or reduce testing if warranted by specification sheet requirements or unique design or process circumstances after notification of the manufacturer.

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TABLE J-I Testing guidelines for changes to a qualified product. 1/ 2/ 3/ 4/ 5/ 6/ 7/ 8

5/ Additional testing and evaluation in accordance with group E to establish confidence in the proposed change shall be performed as required by the qualifying activity (see J.5.6).

6/ New die design requires full qualification.

7/ For small die flow use group B, step 1 in lieu of B3 and C6 requirement; and use group A subgroup 1 (small die only applicable for RHA devices).

8/ Group D tests are only applicable for RHA devices.

19500 Appendix J Group A Qualification Differences

- Group A subgroup 1

small die flow

Subgroup 1 (for small die flow only 2/ 3/)		
Visual and mechanical examination 4 /	2071	116 devices, c = 0 (JANTXV) 45 devices, c = 0 (JAN, JANTX)
Acoustic microscopy	J-STD-035	Test condition per JEDEC J-STD-020 Condition as specified and documented by supplier. Option-temp cycle. No rejects allowed
Solderability 4/	2026	15 leads, c = 0
Resistance to solvents 4/	1022	15 devices, c = 0
Preconditioning	JEDEC JESD22-A113	
Acoustic microscopy	J-STD-035	Test condition per JEDEC J-STD-020 Condition as specified and documented by supplier. Option-temp cycle. No rejects allowed
	JESD22-A102	121C/100%RH t = 96 hrs, or
Autoclave or,	JESD22-A118	130C/85% RH t = 96 hrs, or
UHAST or,		110C/85%RH t =264 hrs
UHAST		

19500 Appendix J Group A Qualification Differences

- Group A subgroup 1

small die flow

Temperature cycling (air to air) 4/	1051	Test condition G, or maximum storage temperature, whichever is less, 25 cycles. 22 devices, c = 0 121C/100%RH t = 96 hrs, or 130C/85% RH t = 96 hrs, or 110C/85%RH t =264 hrs
Autoclave or,	JESD22-A102	121C/100%RH t = 96 hrs, or
UHAST or,	JESD22-A118	130C/85% RH t = 96 hrs, or
UHAST		110C/85%RH t =264 hrs
Temperature cycling (air to air) 4/	1051	Test condition G, or maximum storage temperature, whichever is less, 25 cycles. 22 devices, c = 0
Acoustic microscopy	J-STD-035	Test condition per JEDEC J-STD-020 Condition as specified and documented by supplier.
Electrical measurements (group A, subgroup 2)		
Bond strength 4/	2037	Precondition T_A = +250°C at t = 24 hrs or T_A = +300°C at t = 2 hrs 11 wires, c = 0
Decap internal visual (design verification)	2075	4 devices, c = 0

19500 Appendix J Group B Qualification Differences

- Group B subgroup 2

Sequential testing

Subgroup 2		Start of sequential testing
Acoustic Microscopy	J-STD-035	Test condition per JEDEC J-STD-020 Condition as specified and documented by supplier. Option-temp cycle. No rejects allowed
Preconditioning	JESD22-A113	
Acoustic Microscopy	J-STD-035	Test condition per JEDEC J-STD-020 Condition as specified and documented by supplier. Option-temp cycle. No rejects allowed
Autoclave , or	JESD22-A102	121C/100% RH, 96 hours or
UHAST, or	JESD22-A118	130C/ 100% RH, 96 hours, or
UHAST		110C/85%RH, 264 hours
Electrical measurements 4/		

19500 Appendix J Group B Qualification Differences

- Group B subgroup 2

Sequential testing

Temperature cycling (air-to-air)	1051	Test condition G or maximum storage temperature, whichever is less. (45 cycles including screening)
Autoclave	JESD22 -A102	121C/100%RH t = 96 hrs, or
UHAST, or	JESD22 -A118	130C/100% RH, 96 hours or
UHAST		110C/85% RH, 264 hours
Electrical measurements 4/	1051	Test condition G or maximum storage temperature, whichever is less. (45 cycles including screening)
Temperature cycling (air to air)		
Electrical measurements 4/		
Acoustic Microscopy	J-STD-035	Test condition per JEDEC J-STD-020 Condition as specified and documented by supplier. Option-temp cycle. No rejects allowed
Surge	4066	As specified.

19500 Appendix J Group B Qualification Differences

– Group B subgroup 4

Subgroup 4		
Acoustic microscopy	J-STD-035	
Decap internal visual (design verification)	2075	Visual criteria in accordance with qualified design. Plastic concerns for 2075. Refer to MIL-STD-1580 Requirement 16 for plastic microcircuits,

19500 Appendix J Group B Qualification Differences

- Group B subgroup 7

Subgroup 7 Glass transition temperature	ASTM 1640	

19500 Appendix J Group C Qualification Differences

− Group C subgroup 2

Subgroup 2		
Acoustic Microscopy	J-STD-035	Test condition per JEDEC J-STD-020 Condition as specified and documented by supplier
Preconditioning	JEDEC JESD22-A113	
Acoustic Microscopy	J-STD-035	Test condition per JEDEC J-STD-020 Condition as specified and documented by supplier.
Temperature cycling (air-to-air)	1051	Test condition G, or maximum storage temperature, whichever is less. (500 cycles).
Acoustic Microscopy		Test condition per JEDEC J-STD-020 Condition as specified and documented by supplier. Option-temp cycle. No rejects allowed
Electrical measurements		Group A, subgroup 2.

19500 Appendix J Group C Qualification Differences

- Group C subgroup 3

Subgroup 3		
Acoustic Microscopy	J-std-035	Test condition per JEDEC J-STD-020 Condition as specified and documented by supplier.
Preconditioning	JEDEC JESD22 -A113	
~~Temperature cycling (Air to air)~~	~~1051~~	~~Test condition G (-55C/+150C), or maximum storage temperature, whichever is less. (100 cycles).~~
Highly Accelerated Stress Test (HAST, Biased)	JEDEC JESD22 -A110	130C/85%RH, biased , 96 hours, or 110C/85%RH, biased, 264 hours
Temperature cycling (air to air)	1051	Test condition G (-55C/+150C), or maximum storage temperature, whichever is less. (100 cycles).
Temp Humidity Bias		85C/85%RH, biased, 1000 hours
Acoustic microscopy	J-STD-035	
Electrical measurements		Group A, subgroup 2.

19500 Appendix J Group E Qualification Differences

- Group E subgroup 9

Subgroup 9			
Acoustic Microscopy	JEDEC J-STD-035	Delamination >10%	10 devices from MSL sample. C = 0
Moisture Sensitivity Level Classification	JEDEC J-STD-020	Test is performed to determine moisture sensitivity level per JEDEC J-STD-020. Conditions will be used based on supplier data available. Moisture level will be the lowest numerical level (1-6) that has no failures based on pass/fail criteria in J-STD-020.	45 devices, c = 0
Acoustic Microscopy 3/	JEDEC J-STD-035	Delamination >10%, no additional delamination from pre-stress.	10 devices from previous Acoustic Microscopy C = 0
Electrical Measurements		Group A, subgroup 2.	45 devices, c = 0

19500 Appendix J Group E Qualification Differences

- Group E subgroup 10

Subgroup 10		
Glassivation Temperature (Tg)	ASTM E1640	
Plastic evaluation	883/5011	Type I electrically conductive or Type II electrically insulative
Construction analysis	SAE6294/3	A construction analysis as per SAE6294/3 is recommended
Outgassing	ASTM E595	